LAND COVER CHANGE PROBLEM:
LESSON: Aerial Photography Interpretation

Purpose

To develop an understanding of how to use an aerial photograph to determine land cover type and to create a selective identification key to aid in interpretation.

Overview

In this unit, students will use aerial photographs to determine land-use within satellite images. The "bird's-eye" view of the earth that aerial photographs and satellite images offer is valuable. When we study the Earth from above we can see things and how they relate to each other in a way that can't be done any other way. An important difference between the types of images is their spatial resolution or how much detail can be seen. This difference is due to the altitude of the aircraft or satellite. Aerial photographs have a very large scale and high resolution (approximately 1 meter pixels.) This means that individual houses and small roads can easily be seen, they generally cover a smaller area than satellite images. Satellite images, in contrast, cover a larger area, have a smaller scale and in most cases lower resolution (in Landsats case the resolution a pixel is 30 meters) so now we can see a larger area while still being able to identify housing developments and large two lane roads are visible.(See Figure API 1)
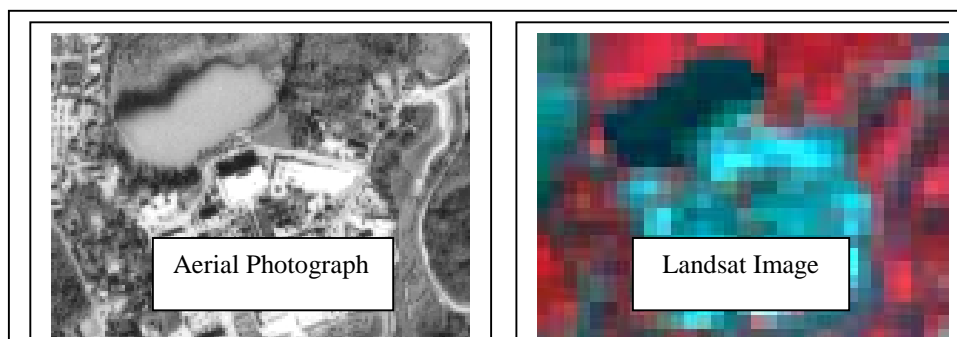

| Aerial Photograph | Landsat Image |

Figure API 1. An NAPP aerial photograph and Landsat color composite (4,3,2) of a part of the city Upper Marlboro that compares spatial resolution.

Aerial photographs are a more efficient and practical way to identify parts of satellite images, especially in the classroom. This identification process, sometimes called ground validation or ground truth, is where information is collected at the same site and at the same time that the satellite image was taken. The "ground validation" interpretation of this units satellite image is completed by using the aerial photographs. This lesson provides the foundation for how the students will use the aerial photos to interpret the satellite images in the change detection lesson.

Once students learn to "read" an aerial photograph they can derive great deal of information about a study area. They can see where houses are in relation to industrial areas. They can determine if a wooded area is an orchard or a forest. They can even tell if the forest is evergreen or deciduous. One way to teach students photo interpretation is to use local aerial photographs. Students will learn to recognize familiar landmarks from this "birds-eye" perspective and can transfer that knowledge to aerial views of different regions. (See Appendix C to acquire data that relates to the student's local school.) When they look at the photos, they "drive" down the roads and pass landmarks in their minds as they visually explore the photos. Quickly, they can spatially make sense of their world in a meaningful manner that will make the satellite image change detection very easy.

Advantages of Aerial Photography over Ground-Based Observation
- Aerial photography offers an improved vantage point (bird's eye view).
- It provides a permanent recording on a larger scale.
- It can have broader spectral sensitivity than the human eye.

(Aerial Photography and Remote Sensing, Shannon Crum, Department of Geography, University of Texas at Austin, 1995. visited 8-6-00)

Interpretation Features

There are *eight* characteristics are used identifying features in an aerial photograph, many of which can be used in satellite images. In this lesson the students are asked to use all eight characteristics to help in identifying of land cover objects.

The information in this section is adapted from the following web sites: **(Volume 1: Air Photo Interpretation and Photogrammetry,** Lecture 2: Elements, Aids, Techniques and Methods of Photographic/Image Interpretation **2.3 Elements of Image Interpretation,** Prof. John E. Estes, Remote Sensing Research Unit Department of Geography University of California) and (**Aerial Photography and Remote Sensing**, Shannon Crum, Department of Geography, University of Texas at Austin, 1995. visited 8-6-00)

1. **Tone** (also called Hue or Color) – "Tone refers to the relative brightness or color of object on a photograph. It is, perhaps, the most basic of the interpretive elements because without tonal differences none of the other elements could be discerned." (Crum, 1995) (Estes, 1998)

   Examples of tone: Example of color:

   To see details click on the images to open them in a web browser

2. **Size** – "The size of objects must be considered in the context of the scale of a photograph. The scale will help you determine if an object is a stock pond or Lake Minnetonka." (Crum, 1995) (Estes, 1998) If an object of a known size in the image, scale can be determined. Example: If a football field is 1 inch long in the aerial photograph and the distance from end-zone to end-zone is 100 yards, then 1-inch = 100 yards.

3. **Shape** – "refers to the general outline of objects. Regular geometric shapes are usually indicators of human presence and use. Some objects can be identified almost solely on the basis of their shapes." (Crum, 1995) (Estes, 1998)
   The Pentagon Building
   (American) football fields
   Cloverleaf highway interchanges

   Examples of shape:
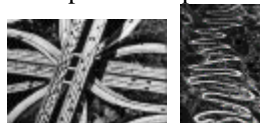
4. **Texture** – "The impression of "smoothness" or "roughness" of image features is caused by the frequency of change of tone in photographs. It is produced by a set of features too small to identify individually. Grass, cement, and water generally appear "smooth", while a forest canopy may appear "rough"."(Crum, 1995) (Estes, 1998)

> Examples of texture is easy to see in the larger image. Click on the image to see the larger image:
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5. **Pattern** *(spatial arrangement)* – "The patterns formed by objects in a photo can be diagnostic. Consider the difference between (1) the random pattern formed by an unmanaged area of trees and (2) the evenly spaced rows formed by an orchard." (Crum, 1995) (Estes, 1998)

> Examples of pattern:
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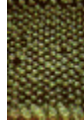
6. **Shadow** – "Shadows aid interpreters in determining the height of objects in aerial photographs. However, they also obscure objects lying within them." (Crum, 1995) (Estes, 1998)   Simply put, the longer the shadow with respect to other shadows in the photo the taller the object.

> Examples of shadow:
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7. **Site** – "refers to topographic or geographic location. This characteristic of photographs is especially important in identifying vegetation types and landforms. For example, large circular depressions in the ground are readily identified as sinkholes in central Florida, where the bedrock consists of limestone. This identification would make little sense, however, if the site were underlain by granite." (Crum, 1995) (Estes, 1998)

> Examples of site:
>
>

8. **Association** – "Some objects are always found *in association with* other objects. The context of an object can provide insight into what it is. For instance, a nuclear power plant is not (generally) going to be found in the midst of single-family housing. But, a playing field with baseball diamonds will be in a residential neighborhood." (Crum, 1995) (Estes, 1998)

Residential	Commercial	Park	Agricultural
Figure API 3.	Figure API 4.	Figure API 5.	Figure API 6.

Student photo interpreters sometimes encounter difficulties when they begin to use aerial photographs. In figure API 3-6, imagine how difficult it would be for students identify some of these image selections if they were not already identified. In this lesson, students will first develop a key to the features they encounter in an aerial photograph. They will use this key and their ability to interpret aerial photographs to identify land cover types in their research area in the final lesson.

Time
- 2 class periods to understanding of how to use an aerial photograph and create a selective identification key
- Time out of class can be used for completing the selective key.

Level
Intermediate and Advanced

Key Concept
Communication skills
> Read and understand images produced by others
> Produce images for other to interpret

Technology/Software Mastery
> Use computer software to scale images
> Use computer software to interpret image

12A Values and Attitudes
> Know why it is important in science to keep honest, clear and accurate records

12B Computation and Estimation
> Use, interpret, and compare numbers
> Estimate distances from maps and actual sizes of objects from scale drawings
> Decide what degree of precision is adequate

12E Critical-Response
> Be aware that there may be more than one good way to interpret a given set of findings
> Be skeptical of arguments based on very small samples of data, biased samples or samples for which there is no control sample

Skills
> *Identifying* images
> *Managing* time

Integrating information
Analyzing data
Interpreting data to make a decision
Drawing conclusions
Using computers
Solve Problems in a group setting
Critically discuss procedures

Materials and Tools

- 2 printed NAPP Aerial photographs for each student group
- All the printouts for each of the NAPP Aerial photographs:

Lanham	Bowie
Upper Marlboro	Bristol

- Selective Key worksheet
- Color printer
- 3-inch square matte board
- Rubber cement
- Scissors

Preparation

Prince George's Data

Manual Selection Key Construction

- Download and print all the aerial photographs using the above materials and tools links.
- Make enough copies (copies are best if each is printed individually) of each aerial photograph to hand out 2 of each photo for each student group.
- Cut enough 3-inch square matte board cards for each student group to have one card. (extras never hurt)
- Cut out the center 1-inch square from the 3-inch square matte board card. This will create the "Selection Key Window."

Local Data (other than Prince George's Data)

Order the most recent NAPP Aerial photographs that cover the entire Landsat image area (remember that if you want to obtain your own Landsat image you want to refer to APPENDIX D: Landsat Resources For Educators) from the USGS from the web site PhotoFinder. Make sure that you do this with enough lead-time prior to the class time so that you can use this fantastic resource. You may want to purchase other aerial photographs from earlier dates to see the changes in your area during and/or prior to the satellite coverage (Landsat satellite coverage is from 1972 to the present.) The NAPP Aerial photographs are an invaluable resource for conducting remote sensing activities in the classroom.

- If ordering local NAPP aerial photographs for use with this lesson, one of the best ways to make copies for the students to use is to go to a copier company and have

them make copies of each photo that increases the size from 9-inch to 12-inch copies. Have the copies laminated. These will be very durable and an easily used classroom resources.

- If you want to interpret the aerial photographs with the aid of a computer, then first scan the photos; 500-300 dpi is the recommended resolution, anything courser will not be useful. Once the images are scanned, then viewing the images can be a problem. To view the images, digital photo editors such as Photoshop or Photo Editor are preferred because the student can zoom in or out of the image If the scanned images are saved as JPEG format, both Netscape and Internet Explorer will open the images, but do not allow any manipulation of the images.

Procedure

- Choose which student groups will work on which sections of the aerial photographs. This section does not need to be the same section that they will use when they interpret the ΔNDVI image in the final lesson.
- Handout to each student or each group two copies of their aerial photograph area, a Selective Key worksheet, Interpretation Feature description sheet and their "Selection Key Window."
- Review with the class the eight characteristics of image interpretation. The students can either go online to review the characteristics, you can develop a PowerPoint presentation or the quick lesson can be completed on the board.
- Using the "Selection Key Window," have each student group select as many as 20 1-inch square areas on the aerial photograph that contain unique objects. (See figure API 7) Then the students place the "Selection Key Window" on one of the two photo copies and when they find an area they think is a good representation of that type of object (the Aerial Photograph Selective Key Worksheet describes how many and types of objects the students need to collect), carefully draw a square around the area using the 1-inch square.
- Continue this process until they have at least 10 different object squares. Some of the squares can be of similar objects, different types of single family houses, but there needs to be some variety. **Try to find at a minimum 2 residential, 2 agricultural, 1 commercial, and 2 transportation objects.**

Make sure that none of the selected squares overlap. Then have the students cut out each of their squares and paste them in the appropriate section of the worksheet. The students need to label on the worksheet each of their squares in the title area above each 1-inch photo square. The figure API 8 is a template of some of the features that they may select

Figure API 7. Students searching for unique objects.

When all the student groups have finished, have the students switch their worksheets and check the accuracy the other groups' interpretation. If both groups disagree with the identification, then they can check with the entire class.

Figure API 8. A template of a selective key similar to the one the students will construct.

AERIAL PHOTOGRAPH SELECTIVE KEY

Image. 1 ∇	Image. 2 ∇	Image. 3 ∇	Image. 4 ∇	Image. 5 ∇
Farms	Residential & Parks	Industrial Park	Forest	Amusement Park
Image. 6 ∇	Image. 7 ∇	Image. 8 ∇	Image. 9 ∇	Image. 10 ∇
Mall	Recreation Park	Race Track	Highway Clover Leaf Intersection	Bridge over River
Image. 11 ∇	Image. 12 ∇	Image. 13 ∇	Image. 14 ∇	Image. 15 ∇
Wetland	Gravel Pit & Landfill	Forested Valley	Urban Railway Station	Urban Reservoir
Image. 16 ∇	Image. 17 ∇	Image. 18 ∇	Image. 19 ∇	Image. 20 ∇
Large Urban Buildings	Urban Residential	Urban School	Urban Bridges over River	Mixed Urban Buildings

AERIAL PHOTOGRAPH SELECTIVE KEY WORKSHEET
Student Group Name _____

Image. 1 ▽	Image. 2 ▽	Image. 3 ▽	Image. 4 ▽	Image. 5 ▽	
Natural Objects:	Natural Objects:	Natural Objects:	Natural Objects:	Natural Objects:	

Image. 6 ▽	Image. 7 ▽	Image. 8 ▽	Image. 9 ▽	Image. 10 ▽	
Residential Objects:	Residential Objects:	Residential Objects:	Residential Objects:	Residential Objects:	

Image. 11 ▽	Image. 12 ▽	Image. 13 ▽	Image. 14 ▽	Image. 15 ▽	
Transportation	Transportation	Transportation	Commercial	Commercial	

Image. 16 ▽	Image. 17 ▽	Image. 18 ▽	Image. 19 ▽	Image. 20 ▽	
Other	Other	Other	Other	Other	